Ethnoecology and Planting Practices in a Swidden Agricultural System

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introduction

Ethnoecology, a distinctive approach to human ecology which draws its goals and methods from ethnoscience (Conklin 1967; Frake 1962), holds promise of rich rewards for the ecologically-oriented fieldworker. With an explicit theoretical framework and well-operationalized methodology, ethnoecology provides a more scientifically reliable field technique for discovering cognitive aspects of man-environment relationships than has hitherto been available.

Nonetheless, the promise one senses in ethnoecology is not accompanied by an equivalent sense of fulfillment. Berreman (1966:351), for example, has charged that analyses of such domains as color (Conklin 1955), firewood (Metzger and Williams 1966), and disease terms (Frake 1961) are really rather trivial. Vayda and Rappaport (1968:491), while defending the importance of cognitive studies in ecology, have found the presentation of paradigms and taxonomies which characterize many ethnoecological studies to be examples of "ethnosystematics" rather than ethnoecology. And Harris (1968:570-572) has criticized ethnoscience in general for not verifying the importance of its cognitive analyses in the everyday behavior of the people being studied.

This last criticism by Harris seems to capture the essence of the others' criticisms as well, for it is the segregation of cognitive analyses from practical activities which gives them the appearance of being trivial and of dealing only with "systematics." Perhaps it was a premonition of such criticisms as these which led Frake quite early to defend ethnoecology as "a legitimate study in its own right" and not "simply as a methodological adjunct to nobler tasks" (Frake 1962:53-54). And such a restricted scope may even have been appropriate to a pioneering effort, where the task of translating a theoretical perspective into workable field methods demanded much concerted energy. Now, however, that time is past, and analyses of the shared cognitive aspects of human

Two sets of data on slash-and-burn agriculture in Northeast Brazil are compared. The first constitutes a cognitive paradigm of land types and the rules stating which crops "like" which lands best. The second shows the actual outcomes, for forty-four agriculturalists, of planting specific crops in specific land types. The cognitive model predicts the direction in which actual planting behavior deviates from randomness, although many interesting exceptions occur. The need for similar analyses in other cultures and spheres of activity is stressed, and techniques appropriate to the task are discussed.

ecological systems must increasingly take into account the behavior which connects a people's ideas to the external environment in which they attempt to survive.

In this paper, I will be concerned with the extent to which cognitive models generated by ethnoecological techniques may be used to predict actual practices in specific contexts. Data collected among slash-and-burn agriculturalists in Northeastern Brazil will be used to show that even a relatively simple cognitive paradigm may predict actual outcomes with a considerable degree of accuracy. Due to a lack of equivalent data on other agricultural societies, however, the comparative significance of this predictive power is difficult to judge. The conclusions of the paper, therefore, will be less concerned with theory than methodology, especially the development of fieldwork procedures for collecting the sort of data which are prerequisite to similar analyses in the other settings.

The data I will use to illustrate these remarks are of two distinct types: a set of essentially cognitive materials elicited with the techniques of "frame analysis" (Black and Metzger 1965; Metzger and Williams 1966); and a set of "behavioral" data, collected through direct observation and informant recall. Since the two sets of data were not collected for the express purpose of comparison, they fall short of ideal scientific standards in some cases.[2] I indicate these cases as they occur and, in the conclusion, suggest ways in which similar shortcomings may be avoided in future fieldwork.

land and crops: cognition and practice

The data were collected among a group of sharecroppers on a plantation in Ceará, Brazil (Johnson 1971). The plantation, located in the semi-arid *sertão* of the Brazilian Northeast, is owned by an absentee landlord who derives his profits from the sale of cotton, cattle, fruits, and various staple food crops. The tenants live in nuclear family households, receiving rights to a house, water, firewood, and land in exchange for shares of their produce. Tenants clear and burn new fields of their own each year, using portions of second-growth forest allotted to them by the plantation manager. In these swiddens they raise maize, beans, bitter manioc, and other crops for home consumption, and cotton for sale. They continue to care for older swiddens for several years before allowing them to revert to secondary forest.

the types of lands The first set of data is a land typology collected through the eliciting techniques of ethnoscience. The procedures for this type of analysis are essentially three: first, the collection of a corpus of terms from which a reduced set of stable, mutually contrasting terms is derived; second, the discovery of the semantic organization of the terms, using the principles by which native speakers contrast terms and group them into larger categories; and third, the development of a set of what I will refer to as "rules of correspondence," by which informants relate their "native concepts" to the world of practical experience. Together, these procedures approach the goal of ethnoscientific research as stated by Goodenough (1964): a description "of whatever it is one has to know or believe in order to operate in a manner acceptable to [a society's] members."

Among the Brazilian sharecroppers, the first step was accomplished with the frame "*Quais são as qualidades de terra que têm?*" ("What are the kinds of land that one has?").[3] This frame elicited a large list of terms which were not mutually contrasting taken together, but which embraced two different levels of contrast. One referred to the use of materials for house construction (clay, sand, gravel, rock); the other referred to agricultural land. Materials like clay or sand could be found in a number of different

types of agricultural land, and different plots of the same type of agricultural land could contain different proportions of these materials. Within the context of the plantation, the frame elicited fifteen terms for agricultural land: *roçado nôvo, capoeira, capoeira velha, campestre, coroa, corgo, rio, lagoa, baixo, brejo, vasante, lastro, quintal, salgada,* and *sitio.* Of these terms, *corgo* (river margin), *quintal* (backyard), *lastro* (single-crop field), *sitio* (irrigated land), and *campo* (field from which tree stumps have been removed for plowing) overlap with other terms; *lagoa* (lake), *baixo* (lowland), *brejo* (swamp), and *vasante* (margin of reservoir) form one concept (low-lying, moist lands of poor drainage) in contrast with the others. Thus we emerge with eight stable, mutually contrasting concepts (see Table 1).

Table 1

Term	Gloss
roçado nôvo	first-year swidden
capoeira	second-year swidden
capoeira velha	"old swidden" (third year +)
campestre	sandy hillside
coroa	river margin
rio	river bottom in dry season (may or may not use fertilizer)
lagoa, baixo, etc. (no cover term)	low, moist
salgada	saline

To complete step two, the discovery of the interrelations among the terms, a second frame was employed: "*Qual ê a diferença entre* ____ *e* ____ ?" ("What is the difference between ____ and ____ ?"). This frame elicited a number of dimensions of contrast, but two are of special interest here because of the high frequency with which informants used them, and because taken together they serve to distinguish all the terms from one another. The first is "fertility," reflecting yields per hectare and signified by the polar opposites "strong" (*forte*) and "weak" (*fraca*); the second is "moisture," represented by the terms "hot" (*quente*) for dry land and "cold" (*frio*) for wet land. The placement of the land types with respect to these two dimensions is represented in Figure 1.

The strong-weak dimension may be taken as an ordinal scale in a scheme of folk measurement; one type can be said to be stronger or weaker than another, but there is no way of saying how much stronger or weaker. In a few cases, informants used the hot-cold dimension in this ordinal fashion as well, but as the data are not conclusive on this point, for this paper the dimension will be regarded as simply dichotomous.

The cognitive paradigm is "real" to the informants in two senses. First, because the statements it generates, such as "*roçado nôvo* is hotter than *coroa* and stronger than *capoeira,*" are regarded as true. Second, because the dimensions hot-cold and strong-weak are the most frequently used in everyday conversation, indicating that their salience to these agriculturalists extends beyond the interview situation.

FORTE (STRONG = fertile)

	roçado nôvo (new swidden)	*coroa* (river margin)
	capoeira (2nd yr. swidden)	*lagoa*, etc. (low, moist)
QUENTE (HOT = dry)		*FRIO* (COLD = wet)
	capoeira velha (old swidden)	*rio* (river bottom)
	campestre (sandy hillside)	*salgada* (saline)

FRACA (WEAK = infertile)

Figure 1. Land Types.

The third step was to describe a set of "rules of correspondence," statements which relate categories to behavior by naming those activities most appropriate to the given categories. In the present study, the rules of correspondence state which categories of crops are most appropriately planted in which categories of land. The rules themselves will be presented individually along with the planting outcomes for each crop, but they are summarized in Figure 2.

STRONG LAND

	squash	manioc M	
	manioc C		
HOT LAND	beans C	beans M	COLD LAND
	maize		
	cotton M	potatoes	

—NO CROPS—

WEAK LAND

Figure 2. Appropriate planting of crops with reference to the land types paradigm. From Johnson 1968:66-68.

Since I was still developing this procedure while in the field, these rules were not as carefully elicited as were the land types (although they ought to have been). The rules presented here were drawn from notes after I left the field, and data on two crops, fava beans and rice, are inadequate. Nonetheless, I constructed these rules and Figure 2 several years before I processed the statistical data on planting. In this sense, also, the two sets of data are separate,[2] and the correspondences and discrepancies between them remain interesting.

the outcomes of planting The cognitive model presented in Figure 1 contains no information beyond the two dimensions of fertility and moisture. By ignoring such factors as soil pests, aspects of the field relative to the sun and wind, and the number of years fallow prior to clearing, the model does violence not only to the teachings of agricultural science, but to the range of knowledge of my informants themselves. They discuss these factors among others, and they are capable of making much finer distinctions between particular plots (or parts of plots) than the land types paradigm permits. Doubtless, a more extensive cognitive analysis would generate a multidimensional model of greater predictive value than this one. The practical difficulty, however, is that these detailed understandings are difficult to elicit and more often reflect individual skill than shared cultural information. It is in the nature of things, therefore, that any shared cognitive paradigm will predict only *some* of the variation in a distribution of actual outcomes.[4]

To begin with the simplest cases, we may consider those rules of correspondence which are never violated in practice. One rule states that one need not bother planting crops in *campestre*; the same is also said of *salgada*. When asked why, the reply is, "It won't yield, it's too weak." A third rule states that it is "almost worthless" (*quasi não da*) to plant an old swidden (*capoeira velha*). And a fourth rule of correspondence states that the river bottom (*rio*) will only produce potatoes. All of these rules were followed without exception. Of the forty-four tenants interviewed and observed in this study, none planted in *campestre* or *salgada*, none planted anything but potatoes in *rio*, and none planted any new crops in *capoeira velha* (workers continue to care for tree-cotton plants up to fifteen years after they stop planting other crops).

If all the rules of correspondence connecting the land types scheme to planting were followed without exception, there would be little of further interest to say at this point. The majority of crops, however, conform to the correspondence rules in only a statistical sense, with many interesting exceptional cases.

The four types of land we have just dispensed with account for little of the agricultural activity on the plantation. Over 90 percent of all produce raised on the plantation (not including the landlord's irrigated fruit gardens) is grown in the remaining four types of fields: *roçado nôvo, capoeira, coroa,* and *lagoa.* Of the total land area represented by these four types of land, ninety fields, or 54 percent of this area, are in first-year swiddens (*roçados*), fifty-nine fields and 35 percent of the area are in second-year swiddens (*capoeiras*), forty-five fields and 9 percent of the area are in river margin fields (*coroas*), and ten fields with 2 percent of the area are in low, wet lands (*lagoa, baixo,* etc.; see Figure 3).

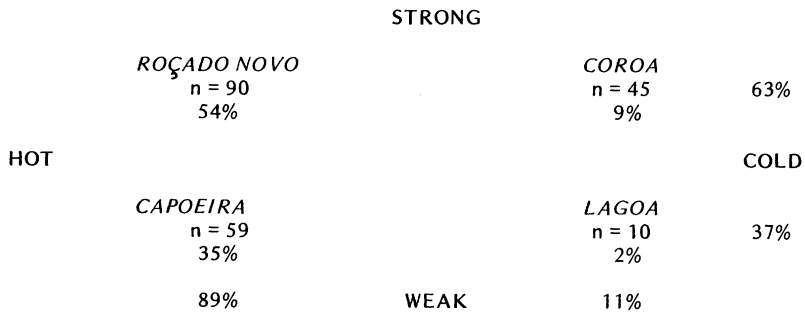

Figure 3. The four major land types by number of fields and land area.

Informants will usually state that a certain crop "prefers" one kind of land over another. In order to judge whether or not actual planting conforms to these statements, I take as the null hypothesis that crops are planted at random with respect to the land types and rules of correspondence. We would expect, therefore, under the null hypothesis, that the amount of each crop planted is proportional to the amount of land available for each land type. That is, 54 percent of each crop should be planted in first-year swidden, 35 percent in second-year swidden, 9 percent in river margin, and 2 percent in low, wet land. This would mean, as well, that 63 percent of each crop would be planted in strong land, 37 percent in weak land, 89 percent in hot land, and 11 percent in cold land. In order to evaluate the extent to which actual outcomes deviate from the null hypothesis in the direction predicted by the correspondence rule, we need to know what percentages of each crop are planted in each of the four land types.

The first case, squash, will illustrate the technique. The correspondence rule for squash states that it "likes" soils which are strong and hot. Table 2 confirms this rule, since *roçado nôvo*, the hottest and strongest land, comprises only 54 percent of the land area, whereas it contains 87 percent of the squash plants.

Table 2
SQUASH*
(486 plants)

RC	425 87%			4 1%	CR
		54	9		
		35	2		
CP	57 12%			0	LW

*This fourfold table corresponds to the four cells of Figure 3. Numbers represent either number of plants or liters of seed, while percentages represent how much of the total of that crop is planted in that particular land type. RC = *roçado nôvo*, CP = *capoeira*, CR = *coroa*, LW = *lagoa*. Percentages in the four cells may not total 100% because not all crops are planted in just these four types of field. Percentages in the inner squares represent the expected planting outcomes under the null hypothesis.

By way of contrast, manioc *manipeba* is said to "prefer" soils which are strong and cold, and confirmation is very strong (see Table 3). Manioc is divided into two varieties, however, the second of which is said to prefer hot soils; it is also said to have the

Table 3
MANIOC *MANIPEBA*
(22,600 plants)

RC	0			22,600 100%	CR
		54	9		
		35	2		
CP	0			0	LW

Table 4
MANIOC *CARREGADEIRA*
(51,000 plants)

RC	7,100 14%			4,200 8%	CR
		54	9		
		35	2		
CP	33,700 66%			6,000 12%	LW

advantage over the first of growing well in "weaker" soils.[5] This manioc is represented in Table 4. By contrast with *manipeba, carregadeira* earns its "hot land" reputation. Taken alone, however, manioc *carregadeira* cannot really be described as a hot-land crop, despite the rule of correspondence, since only 80 percent of this crop is planted in hot land whereas 89 percent of the available land is hot.

Furthermore, the land types paradigm does not explain all the differences in planting the two types of manioc. Although we can expect more manioc *carredageira* to be planted in weaker land than manioc *manipeba,* the rules of correspondence do not prepare us to find that fully 78 percent of the crop is being planted in the weakest 37 percent of the land. In fact, a new principle has entered the picture: informants state that manioc does not grow well in combination with other crops, and they generally plant it in single-crop fields (*lastro*). *Roçado nôvo* is typically planted with a variety of crops, as is the rule in swidden agriculture (Geertz 1963:18-19). The other fields, however, may be partially cultivated as *lastros,* explaining why more hot-land manioc is planted in second-year swiddens than in first-year swiddens.

As noted earlier, no simple cognitive paradigm can predict behavioral outcomes absolutely. The example of manioc suggests a way in which a more complex paradigm, including the additional principle of crop interference and the single-crop field, would increase the predictive power of the cognitive model. Even in this case, however, we would have to expect a certain amount of deviation in actual practice, since each individual's decisions of "where to plant" are to some extent idiosyncratic, determined by his particular circumstances and understandings, which may not be shared with anyone else.

Table 5
BEANS *DE CORDA*
(187 liters)

RC	142 76%			3 2%	CR
		54	9		
		35	2		
CP	42 22%			0	LW

Table 6
BEANS *DE MOITA*
(41 liters)

RC	4 10%			15 36%	CR
		54	9		
		35	2		
CP	18 44%			4 10%	LW

For example, informants distinguish two types of beans which, like manioc, are said to prefer hot land and cold land respectively. The hot-land beans, *de corda*, are indeed planted 98 percent of the time in hot land (see Table 5). Likewise cold-land beans, *de moita*, are planted 46 percent of the time in the 11 percent of the land which is cold (see Table 6).

But what of the numerous exceptions to the correspondence rules for beans? Some of them, as with manioc, involve *lastros* (e.g., the high frequency of cold-land beans in second-year swiddens in Table 6). Others, however, may have a more idiosyncratic basis. One tenant, for example, planted cold-land beans in a hot-land plot next to his house. When questioned about this, he pointed out that cold-land beans yield sooner than hot-land beans, which makes them an important food source early in the harvest season. This tenant had a piece of cold river margin land, but it was across the river and was likely to be inaccessible during the flood stage of the river, just at the time the early beans were ripening. Other tenants in his position did not make this decision, but they would have regarded his decision as appropriate.

Most potatoes are planted in the cold river bottom during the dry season; the proportions of potatoes planted in the four main types of land, however, confirm their reputation as a cold-land crop. The unusually high frequencies in the weaker lands, as seen in Table 7, may again be explained by the tendency to plant potatoes in single-crop fields.

I have left maize for the last only because its planting is apparently unrelated to the land types paradigm. Informants believe maize to be a crop that does well in most kinds

Table 7
POTATOES
(97,274 plants)

RC	1,265 1%			7,800 8%	CR
		54	9		
		35	2		
CP	4,710 5%			6,000 6%	LW

Table 8
MAIZE
(2,558 liters)

RC	1,685 66%			317 12%	CR
		54	9		
		35	2		
CP	520 20%			10 1%	LW

of land, and their planting reflects this, although stronger land is more often selected (Table 8).

If, as appears to be the case, knowledge of the land types scheme and the rules of correspondence allows one to predict general trends which are confirmed by evidence from actual planting of crops, it should also be possible to predict features of the informant's cognitive system from the planting data. As noted earlier, insufficient data exist to formulate rules of correspondence for rice and fava beans. Yet, from the planting distributions in Tables 9 and 10, one could predict that rice is regarded as a crop which "likes" strong land, whether it is hot or cold, whereas fava is a hot-land crop.

Table 9
RICE
(246 liters)

RC	192 78%			32 13%	CR
		54	9		
		35	2		
CP	9 4%			13 5%	LW

Table 10
FAVA BEANS
(239 liters)

RC	154 64%			3 1%	CR
		54	9		
		35	2		
CP	79 33%			1 1%	LW

discussion

The two sets of data reported here are in relatively close agreement. The rules of correspondence predict the direction of deviation from a random planting pattern in every case for which there is data (except maize, where the correspondence rule predicts a random pattern). Of the many deviations that occur, some appear to represent the random scatter which is found in any large number of cases, while others seem to reflect the operation of rules which are not included in the land types paradigm. Nonetheless, this relatively simple cognitive model does appear to summarize or account for the main trends in observed planting behavior.

The significance of this finding is difficult to assess because there are no standards for comparison. Whether the correspondence between the land types paradigm and planting activity is high or low may only be determined relative to other studies employing a similar method. For the remainder of this paper, therefore, I will address three questions: What will be the importance of further studies of this kind? What does ethnoecology presently have to offer? And what research procedures must be adopted to advance beyond existing studies?

The first question resurrects the criticism of ethnoscience as the "science of trivia." The present study may be defended from such a charge in two ways. First, although anyone who has ever planted a garden knows that moisture and fertility are two factors of central importance to successful horticulture, one may not assume *a priori* that these factors will have cognitive salience in another culture. The cognitive model of land types described here, obvious as it may appear, remains of comparative interest because the dimensions of moisture and fertility were derived nondirectively, as free as possible from the anthropologist's biases in the matter. Berreman's criticism that domains like disease and firewood are uninteresting contains an indefensible element of ethnocentrism, for such domains are very important to the people being studied. If our task is to know another culture, then we may not regard as trivial those matters to which that culture ascribes importance.

The other defense is methodological. The relationship between cognition and behavior, where it is not mere speculation at a high level of abstraction, may be approached from a number of directions, employing a variety of methods each of which will produce distinct results. For example, the entity "cognition" investigated by a laboratory psychologist is not exactly isomorphic to the entity "cognition" investigated by an ethnoecologist. The methods, to an extent, define the subject of study. Whether or not we want to maintain, as a matter of personal philosophy or faith, that "cognition" is a single thing which can ultimately come to be known, the fact remains that at present we are limited to our various methods of investigation, each of which may give only a partial view of the cognition of our informants. The same argument applies to the entity "behavior." The interrelation between cognition and behavior is a great and enduring issue in the social sciences. This paper sheds a modest light on that issue with evidence, both cognitive and behavioral, collected and analyzed by explicit means. What the method sacrifices in breadth and drama of findings is balanced, one hopes, by the maintenance of scientific standards of replicability and intersubjectivity.

Turning to the question of what ethnoecologists have to offer to our knowledge of the relationship between cognition and behavior, I find that this issue is of secondary concern to most of them. The criticisms of ethnoecology outlined in the introduction are not unmerited. Although the prediction of "appropriate behavior" is the main goal of

ethnoecology, actual analyses have usually done no more than demonstrate certain systematic interrelationships within a corpus of terms. That is, one finds many analyses which have proceeded as far as the second procedural step described earlier in this paper, but few which have proceeded to step three, the presentation of the rules of correspondence.

Nor has much interest been shown in comparing the appropriate behavior with the observed behavior in any given domain. We may wonder why the comparison of "appropriate" and "observed" behavior has attracted so little attention; certainly, the idea is not absent in the literature of ethnoscience. Frake (1962) has attempted to account for observed settlement patterns as outcomes of settlement "rules." Metzger and Williams (1966:401-403) have noted that differences in Ladino and Indian concepts of firewood in Mexico are related to the different uses to which they put it.

Geoghegan (1970) has gone even further in his discussion of residential decision-making among the Eastern Samal. Having developed a model of the rules one informant used to decide "appropriate" residence, Geoghegan then compared the predictions of that model with the actual residence situations of 285 persons. He found that the model predicted actual residence with a high degree of accuracy. He concludes, "The results of these tests would certainly seem to indicate the general utility of the descriptive model as an ethnographic statement of the basic principles underlying Eastern Samal residence choices . . ." (1970:12). Of the three studies just mentioned, however, only Geoghegan's presents quantitative statistical evidence of the extent to which there are interconnections between "appropriate" behavior and "observed" behavior.

On this issue Frake has written, "It is not, I think, the ethnographer's task to predict behavior *per se*, but rather to state rules of culturally appropriate behavior" (Frake 1969:133). Here he is quite explicitly drawing a distinction between "culture" and "behavior" which rests, I believe, on the distinction in linguistics between mentally shared rules (*langue*) on the one hand, and outcomes (*parole*) on the other (cf. Greenberg 1971:56-57). The identity of "culture" with "rules" as opposed to "behavior" is also explicit in Schneider's introduction to *American Kinship*: "This book is concerned with the definitions of the units and rules, the *culture* of American kinship; it is not concerned with the patterns of behavior as formulated from systematic observations of each of its actual occurrences" (1968:6; italics mine).

Intentionally or unintentionally, ethnoecological studies have, by focusing on rules to the exclusion of behavior, perpetuated an unfortunate distinction between culture and practical activity which pervaded the early ecological concerns of Kroeber and Forde. Unlike their predecessor Wissler, who was impressed by the close relationship between human cultural traits and natural conditions, and who saw the cause of this relationship in the "adjustment" of the traits to the conditions (Wissler 1926:213, 221-222), Forde and Kroeber emphasized the separateness of culture from environment. Kroeber attacked "the old environmentalism which believed it could find the causes of culture in environment" (Kroeber 1939:1), and Forde supported him with the argument that "in regions closely similar in relief, climate, and vegetation sharply contrasted types of human life are to be found" (Forde 1963:3). Both appear to have regarded culture as a distinct entity, clearly separable from those other entities, the environment on the one hand, and human activity on the other. Culture was the mediator between them: "Between the physical environment and human activity there is always a middle term, a collection of specific objectives and values, a body of knowledge and belief; in other words, a cultural pattern" (Forde 1963:463). The "possibilist" position of Forde and Kroeber saw "diffusion, specific history, and cultural patterns [as] important influences quite apart

from the environmental factors. But these other influences were allowed to constitute a dark middle region between man and his physical environment in which almost anything could happen" (Vayda and Rappaport 1968:482).

Black's recent proposal that the ideal location for ethnoscientific interviewing is a "white room," as free as possible from external social and environmental stimuli, is a modern version of the same view (Black 1969:167-169). The cultural realm, regarded to a great extent as free from the influences of the world of practical activity and necessity, should be studied apart from those influences.

The converse of this view takes as its starting point the ways in which the cultural realm is affected by the processes of adaptation which even culture-bearing animals find unavoidable. The cultural ecology of Julian Steward presents this view (Steward 1955), and, indeed, when Frake defended ethnoecology as "a legitimate study in its own right," he specifically opposed himself to Steward (Frake 1962:53-54). Frake is correct in insisting that both approaches have merit. Yet I would emphasize that the techniques of ethnoscience, developed largely in isolation from the influence of Steward, nonetheless lend themselves very well to the investigation of adaptive processes in which behaving human beings participate.

The finding, reported in this paper, that a relatively simple cognitive model predicts the direction in which planting practices deviate from randomness, is, therefore, of considerable interest. All experienced fieldworkers recognize that individual behavior does not always conform to cultural rules. We have not, it is true, established general guidelines for when to expect conformity to the rules and when to expect nonconformity. But in the ecological sphere, we should expect cultural notions and actual behavior to be in close correspondence, since the validity of the cultural rules is constantly being tested in environmental interactions where the price of confusion and error may be malnutrition, serious injury, or death. Just as in biological adaptation it is not the genes which are tested in the natural arena, but the behavior of the gene-carrying organism, so in cultural adaptation it is not the cultural rules, but the behavior which is found adequate or inadequate in specific contexts. An analysis which disregards actual behavior is thereby deprived of one of the most powerful tools for explaining the form and function of ecological cognition.

That "appropriate" behavior and "observed" behavior correspond in this group of swidden agriculturalists suggests that in this domain, as in Geoghegan's study, the decision-making processes which are operating to generate behavior are available to the anthropologist through verbal elicitation techniques. This may not always be the case, especially where a dominant ideology masks certain realities from the public view. Under which conditions we may expect correspondences or discrepancies, however, will not be clear until many more studies adopting a methodology similar to the one used in this paper have been performed.

I will therefore conclude this discussion by recapitulating the procedure as it was applied in this study and by suggesting how it should be improved. The first two procedural steps, eliciting the basic corpus of terms and discovering the dimensions of contrast differentiating them, are well described by ethnoscientists in works cited earlier. The most serious problem with their methods at this level has been that of sharing. As Harris (1968:585-589) has observed, ethnoscientists tend to assume that cognitive materials are shared by the community without ever demonstrating it. The difficulty arises from too great a dependence on the "well-informed informant."

Yet, a more quantitative demonstration of degrees of sharing in a community is possible. Sanjek, for example, in an analysis of Brazilian racial terms, has shown that for a group of sixty Brazilian informants certain terms are widely shared, despite great individual differences in the occurrence of other terms. Furthermore, the use of widely shared terms by informants in an experimental setting can be predicted from a cognitive model employing a two-dimensional paradigm of skin color and hair form (Sanjek 1971).

In the present analysis, reliance on only six informants is a liability, although they are quite different from one another and what is common to them is likely to be widely shared in the plantation community. A focus on individual behavior requires, as a matter of good practice, that the researcher should assess as thoroughly as possible the cognition of either the entire community or an adequate sample of it; otherwise, he has no way of knowing whether individual differences in behavior represent deviations from a widely shared set of rules, or whether they represent differences of opinion among the actors.

The third procedural step, the elicitation of rules of correspondence, merits at least as much attention as the first two, for this is the point at which the abstract cultural notions about the environment become transformed into concrete, specific behavior, the outcomes of which will either affirm or deny the adaptive effectiveness of the cultural notions. Elicitation of rules of correspondence will be possible in most cases through the use of eliciting frames; but, if other means are used, they must satisfy the canons of nondirectiveness and replicability of results which lie at the core of ethnoecological methodology.

The last procedural step to be dealt with here, which in a sense is only the beginning of many interesting questions to be investigated, is to describe the activities of the community members in the domain under investigation. This description may usefully be given in terms of the categories the people themselves use. For example, in this paper the description of planting behavior is based on informants' definitions of crops and lands; "maize," "cold-land beans," "rice," and so on are the informants' categories, as are "first-year swidden" and "river margin." The use of categories from Western science in this kind of description would in many instances result in a very different analysis (if, for example, our typology of beans or soils were different from the informants' typology). The results of such a "next step" would be of great interest, but would involve different procedures from those being discussed here.

summary

Ethnoecological analyses have been criticized for not proceeding beyond the presentation of native categories and their semantic interrelationships in circumscribed domains. The criticism is fair, not in the sense that domains like color, firewood, or disease are unimportant (for their importance in the cultures studied is surely great), but in the sense that the application of native concepts in daily activities must also be investigated in order to assess the adaptive importance of the concepts to the community.

In order to begin to investigate the relationship of cognition and behavior in environmental interactions, I have compared two closely related sets of data, one derived by the methods of ethnoecology and essentially cognitive, the other derived by observation and informant recall and essentially behavioral. The two sets of data correspond to a considerable degree; that is, the direction of the deviation from randomness of crop planting can be predicted from the cognitive land types model and its associated rules of correspondence; conversely, one could predict the general form of the

rules of correspondence from the quantitative distribution of actual crop planting. Analysis of certain exceptional cases suggested a way to increase the predictive power of the cognitive model by adding an additional principle (crop interference leading to single-crop fields). Other exceptions appear to be the expected random scatter resulting from different individual circumstances and understandings.

Ethnoecologists have treated the investigation of actual behavior as secondary in importance to the investigation of "appropriate" behavior, perpetuating a tendency, deeply rooted in ecological anthropology, to regard culture as distinct and largely autonomous from behavior in the environment. Recognition that, at least in cultural ecology, this cannot be so, requires the researcher to investigate the activities of production as well as the shared understandings of the community regarding production.

The analysis presented here, although incomplete in many respects, has provided a basis from which to derive an appropriate method for involving more behavioral data in ethnoecological analyses. Fieldworkers find that actual behavior frequently deviates from and often contradicts the cultural rules for appropriate behavior. Why are some rules followed while others are broken? Why do some individuals follow rules while others break them? Why are some rules and concepts widely shared while others vary from individual to individual? The answers to these and other questions may begin to emerge as more studies of cognitive models and their associated activities are performed in other domains and other societies.

notes

[1]The data for this paper were processed with the aid of a grant from the Columbia Council for Research in the Social Sciences. Professors Harold Conklin, Roy D'Andrade, and Roger Sanjek read an earlier version, and I wish to thank them for their helpful comments and suggestions.

[2]The cognitive data were collected from six informants at various times during the fieldwork, in structured, nondirective interviews. The behavioral data were collected through a limited number of direct measurements in the swiddens, and through a series of interviews with each of the forty-four male householeads on the plantation. Since most informants did not participate in the cognitive interviews, their responses to the interviews on planting practices were not influenced by previous cognitive interviewing. Nonetheless, as indicated in the discussion, the two sets of data are interconnected through use of a common set of native concepts (e.g., "maize," "new swidden," etc.). A useful further step, not undertaken in the research reported here, would be direct measurement of all relevant ecological variables (soil composition, crop frequencies, etc.) in order to eliminate altogether any influence the informants' cognition might have on the "behavioral" data.

[3]The frames and "native concepts" (Black and Metzger 1969:137) are shared by six informants. Whether they are more widely shared I cannot assert. The importance of a more quantitative approach to sharing is dealt with in the discussion.

[4]The problem exists for all anthropologists: individual behavioral deviations from the cultural norms, resulting from a variety of circumstances, are found in every population, no matter how "traditional" (Johnson 1972).

[5]Both varieties are bitter manioc. Sweet manioc (*macacheira*) is rarely planted.

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